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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Albuquerque, New Mexico

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William D. Purtymun and William R. Kennedy[1/]

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Prepared in cooperation with the U.S. Atomic Energy Commission and the Los Alamos Scientific Laboratory, Los Alamos, New Mexico

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1/ Group Leader H-6, Los Alamos Scientific Laboratory

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Abstract

The contaminated waste pit near Technical Area 21 was investigated to determine if waterborne radioactive contaminants had migrated from the pit into the adjacent soil and tuff. Thirteen test holes, ranging in depth from 25 to 50 feet, were drilled through the soil into the underlying tuff in the vicinity of the waste pit. No holes were drilled through the base of the pit as only the surface of the pit and adjacent land is considered for commercial use. The distribution of moisture in the soil and tuff penetrated by the test holes was determined by a neutron-scattering moisture probe. Samples of drill cuttings of the soil and tuff were analyzed for gross alpha and gross beta-gamma radioactivities, and plutonium and uranium.

The moisture content of the tuff adjacent to the test holes indicated that the tuff was not saturated. Radiochemical analyses of soil and tuff indicated no radioactive contamination.

1/ Group Leader H-6, Los Alamos Scientific Laboratory

Introduction

The laboratories and test areas of the Los Alamos Scientific Laboratory are on the Pajarito Plateau in north-central New Mexico. The Pajarito Plateau, formed by a series of ashflow and ashfall tuff, is dissected into a number of finger-like mesas that slope eastward from the Sierra de los Valles toward the Rio Grande (fig. 1). Solid wastes, impregnated with or containing radioactive contamination, and sludges and some liquids that contain radioactive particles are buried in pits dug into the surface of these mesas.

One of the oldest contaminated waste pits is located near Technical Area 21 (DP-West). Between 1945 and 1947 the pit was filled with wastes containing mostly alpha radioactive contaminants.

The area of the waste pit is about 250,000 square feet; the original depth was about 20 feet. The present surface of the filled-in pit area is irregular. Drainage is to the south and grasses and oak shrubs grow in the fill material. Around the pit the surface of the mesa slopes gently to the south towards a small canyon which has nearly vertical walls (fig. 2). This canyon is confluent with Los Alamos Canyon a short distance downgradient from the disposal pit. At the confluence the floor of Los Alamos Canyon is about 400 feet below the surface of the mesa.

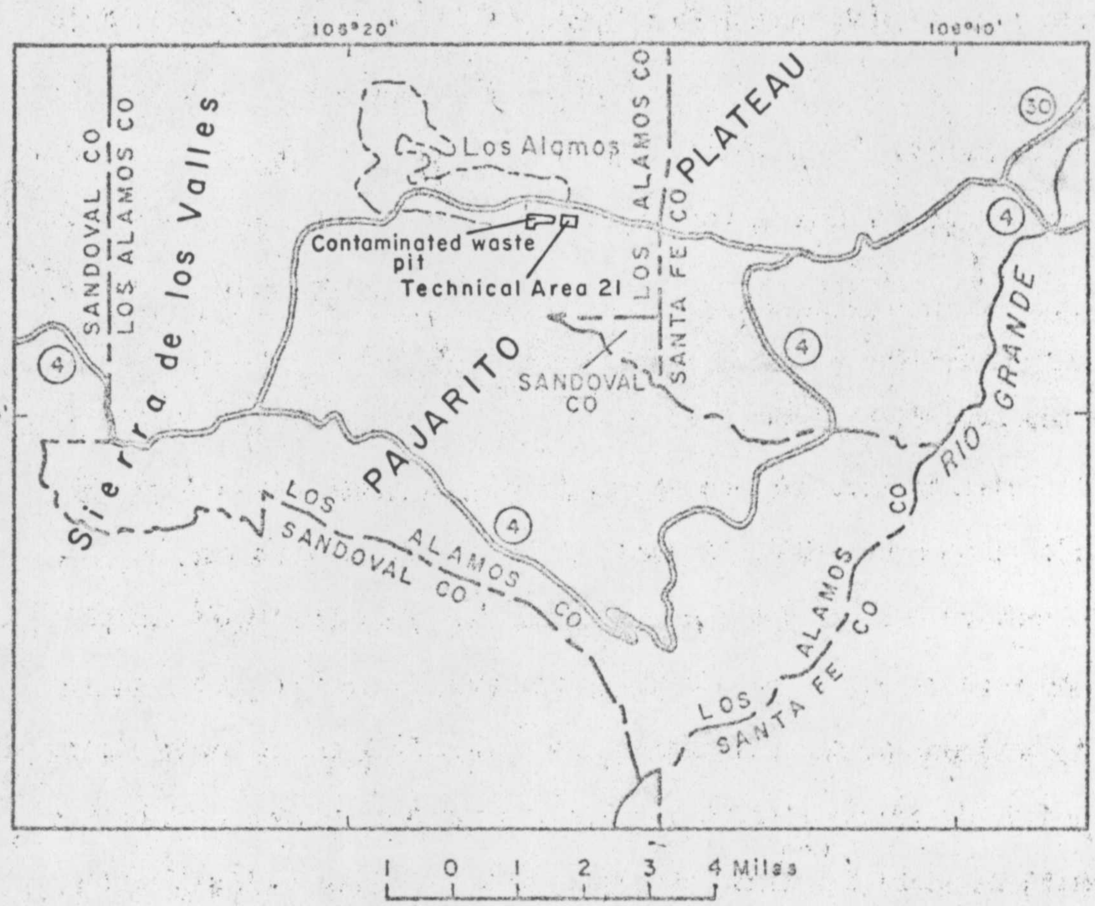
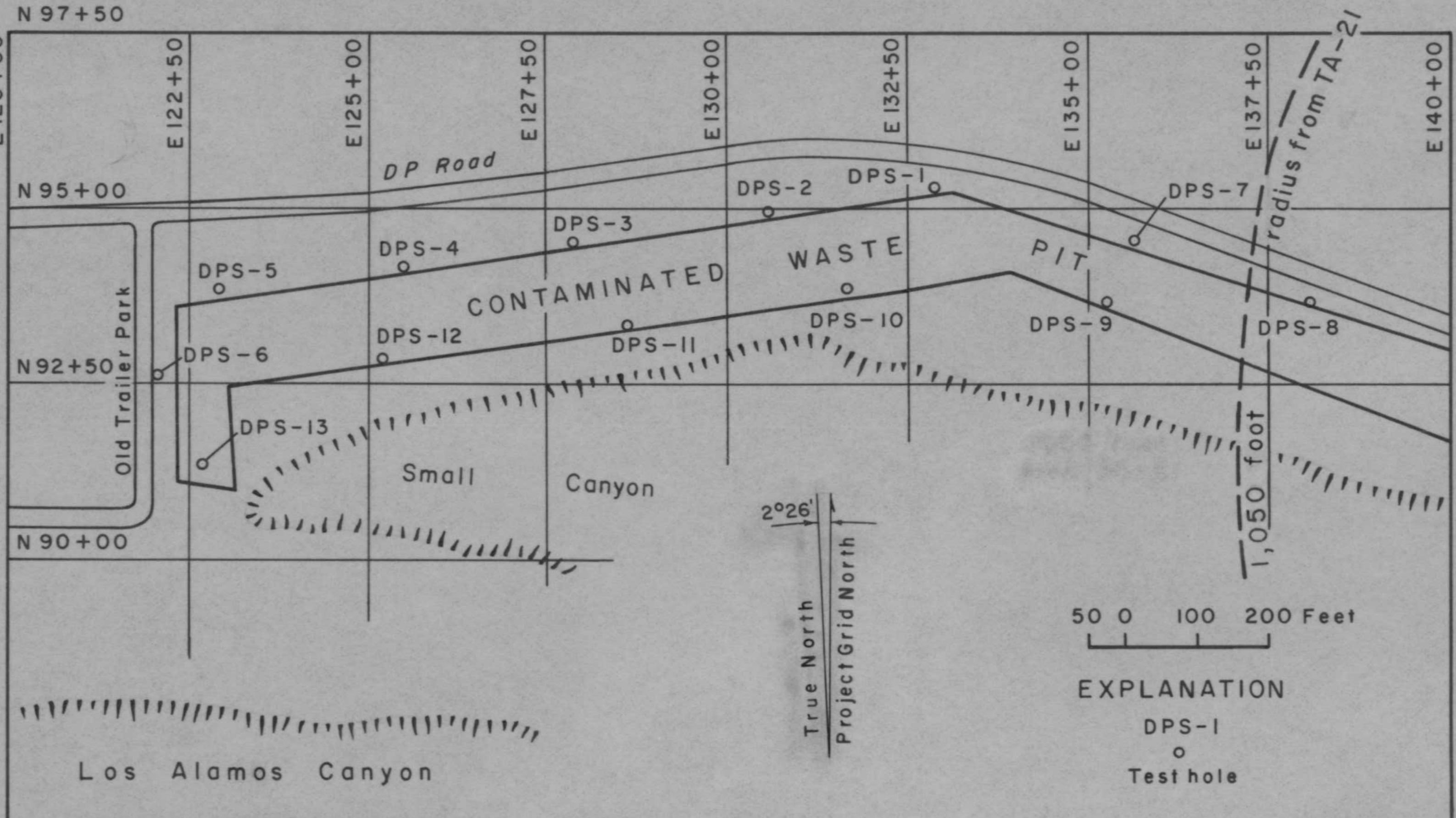


Figure 1.--Map of the Los Alamos area showing location of contaminated waste pit.

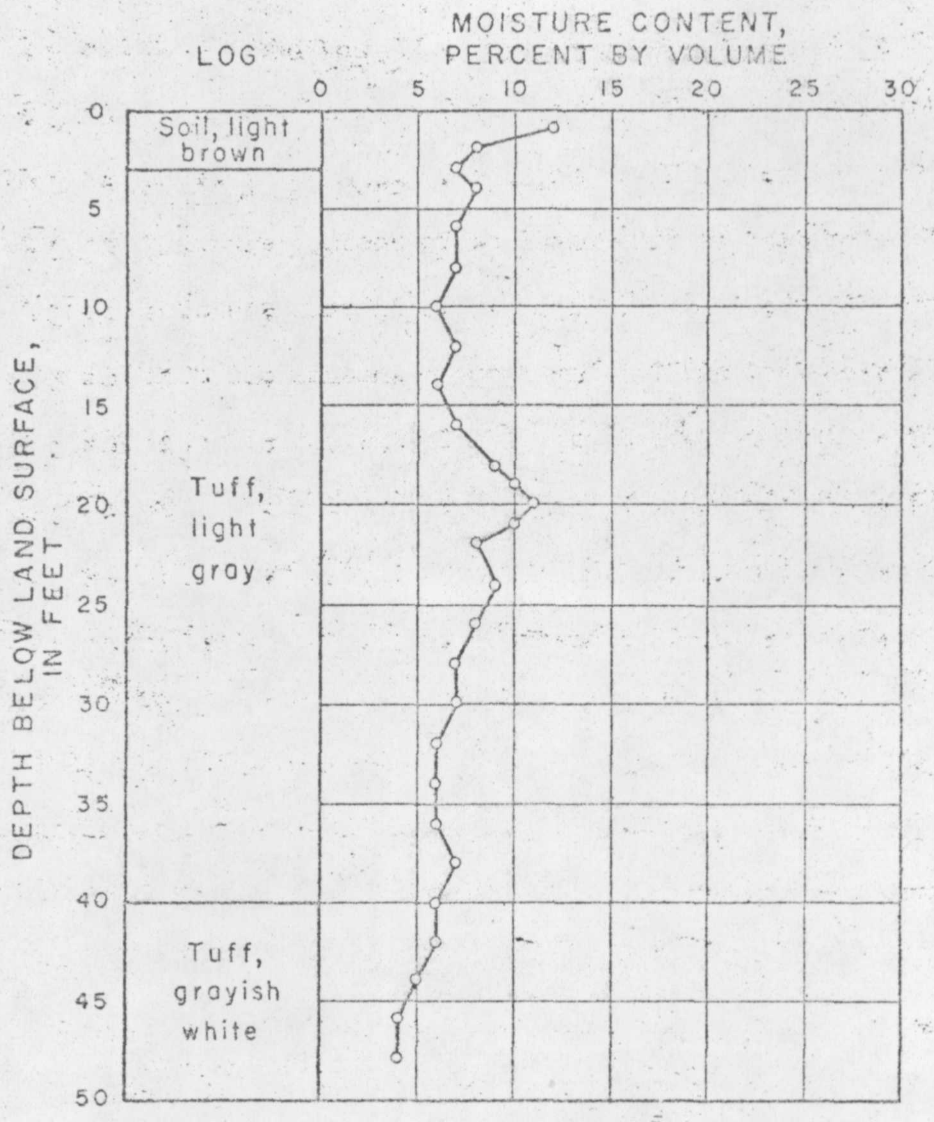


Base from Los Alamos Scientific Laboratory Engineering sheet N.10 - E.7

Expansion of laboratory facilities and increased growth of the community of Los Alamos has caused a re-evaluation of present land use to determine if the land is being utilized in the best possible way. It was proposed by the Los Alamos Scientific Laboratory and the U.S. Atomic Energy Commission that a part of the filled-in contaminated waste pit, outside the radius of 1,050 feet from TA-21 (an area approved for commercial property), be leveled, filled where necessary, and sealed with asphalt, and used for a storage area for trailers and boats. Also, the land adjacent to the pit could be utilized for commercial use.

A joint study, requested by the Engineering Division, LASL, and the Construction and Maintenance Branch, AEC, was made by Group H-6 of the Los Alamos Scientific Laboratory and the Water Resources Division of the U.S. Geological Survey to determine if seepage of water from precipitation had caused migration of radioactive contaminants from the pit into the adjacent soil and tuff. The study was confined to an area slightly within and considerably beyond a radius of 1,050 feet from Technical Area 21 (fig. 2)--an area approved for commercial property.

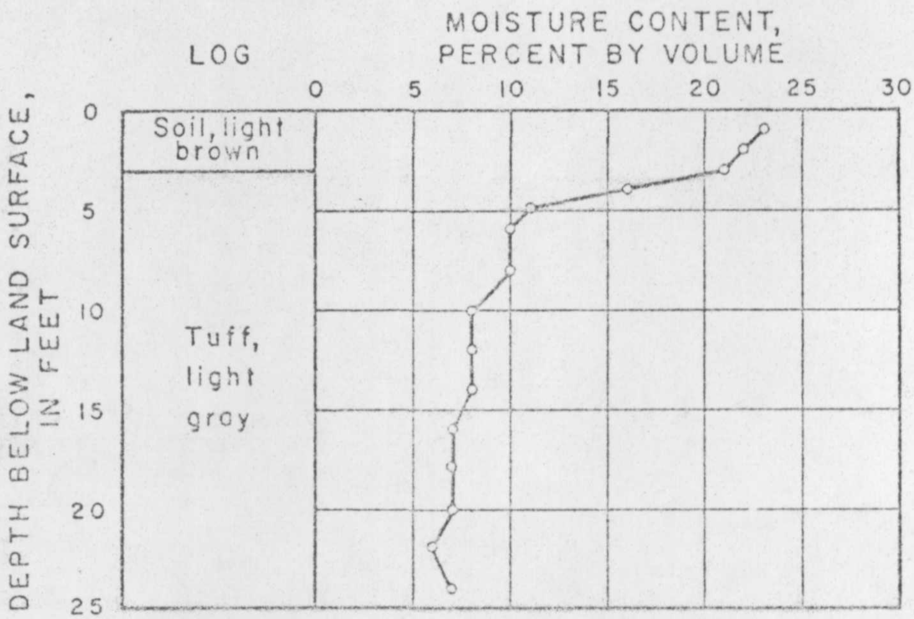
Thirteen test holes ranging in depth from 25 to 50 feet were drilled in the vicinity of the outer edges of the waste pit (fig. 2). The log and moisture content of the soil and tuff penetrated by the test holes are shown in figures 3 through 15. Samples of soil and tuff were collected during drilling of the holes and were analyzed by Group H-6 for radioactive contamination. The results of these analyses are shown on tables 1 through 13.



Location: Project grid, N95 + 13, E132 + 97
Date drilled: 2-7-66
Altitude: 7,190 feet above mean sea level
Depth: 50 feet
Diameter: 4-inches

Figure 3.--Log and moisture content of soil

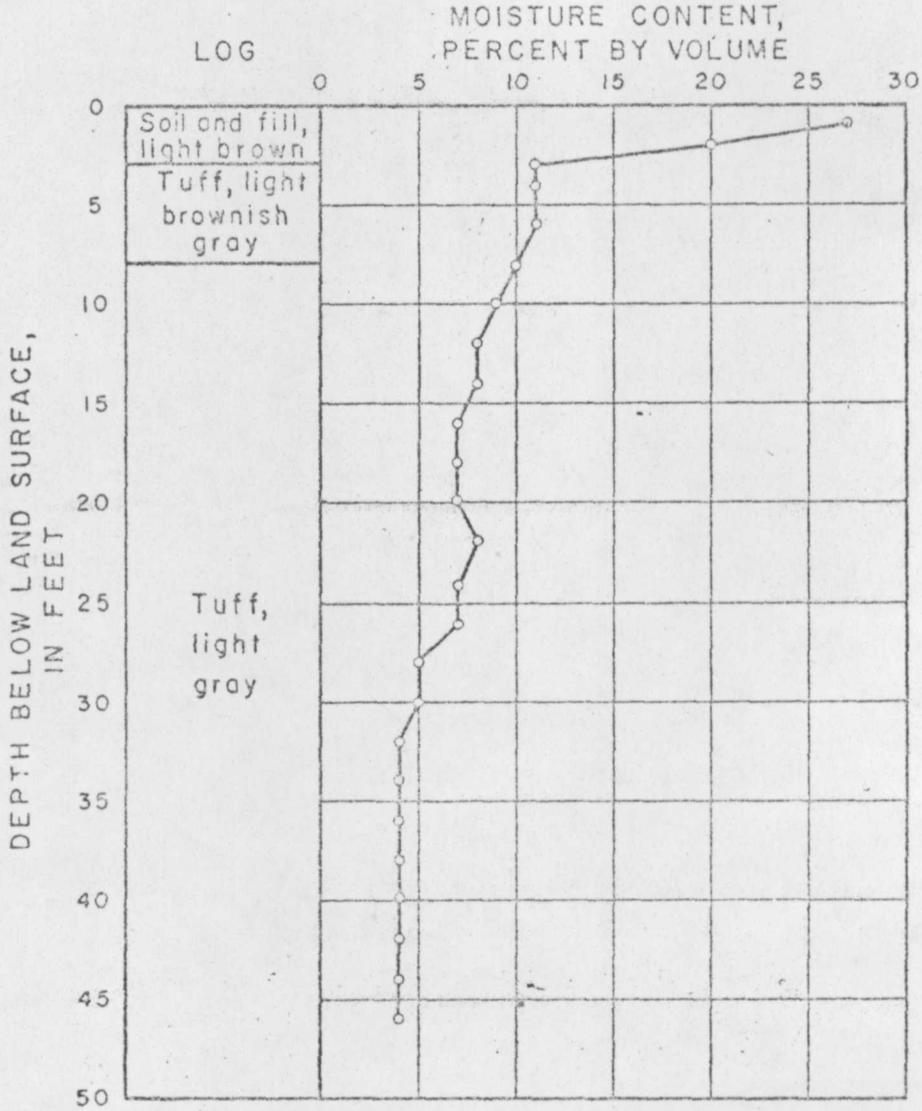
and tuff in test hole DPS-1



Location: Project grid, N94 + 78, E130 + 56
Date drilled: 2-7-66
Altitude: 7,191 feet above mean sea level
Depth: 25 feet
Diameter: 4-inches

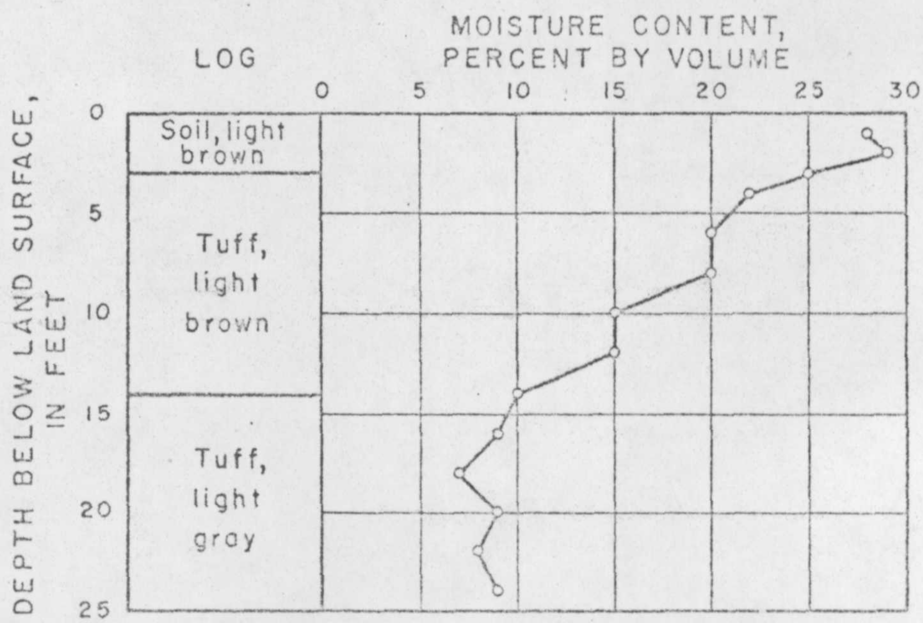
Figure 4.--Log and moisture content of soil

and tuff in test hole DPS-2



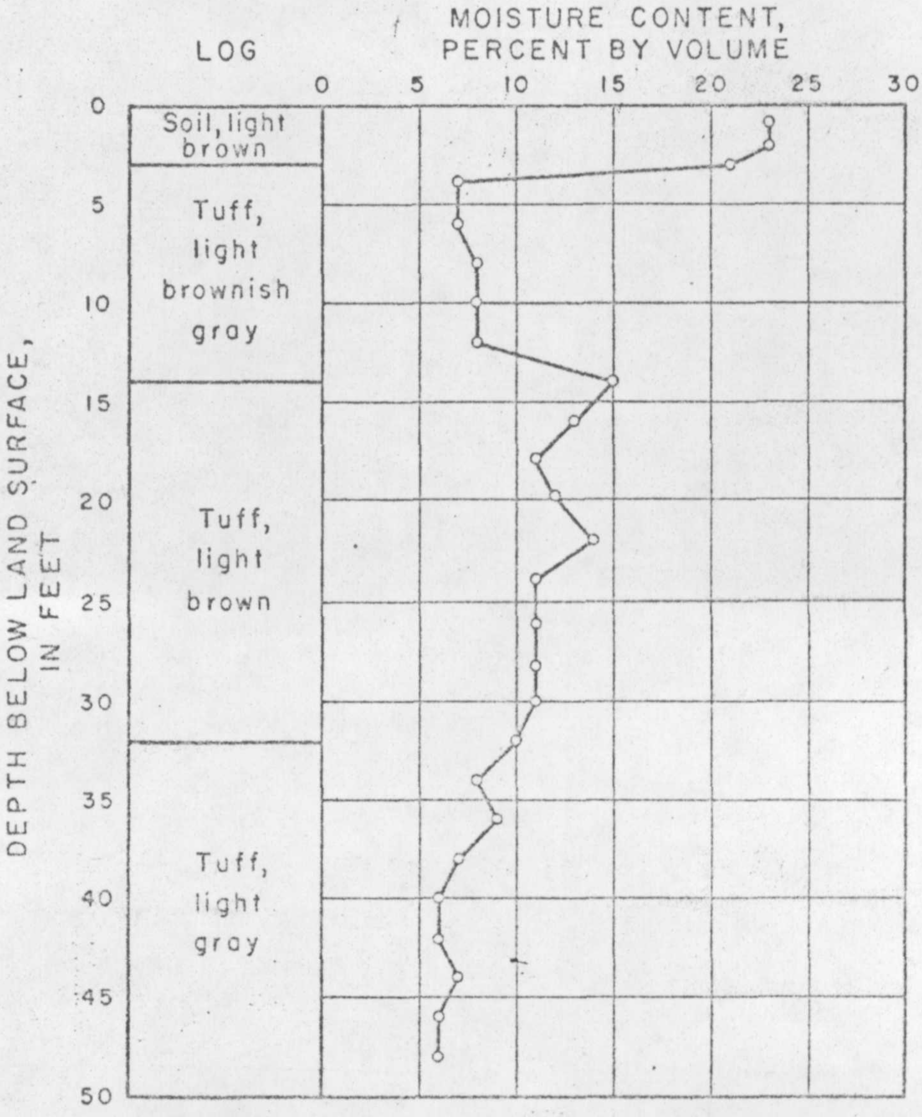
Location: Project grid, N94 + 43, E127 + 87
Date drilled: 2-7-66
Altitude: 7,194 feet above mean sea level
Depth: 50 feet
Diameter: 4-inches

Figure 5.--Log and moisture content of soil and tuff in test hole DPS-3



Location: Project grid, N94 + 16, E125 + 89
Date drilled: 2-7-66
Altitude: 7,202 feet above mean sea level
Depth: 25 feet
Diameter: 4-inches

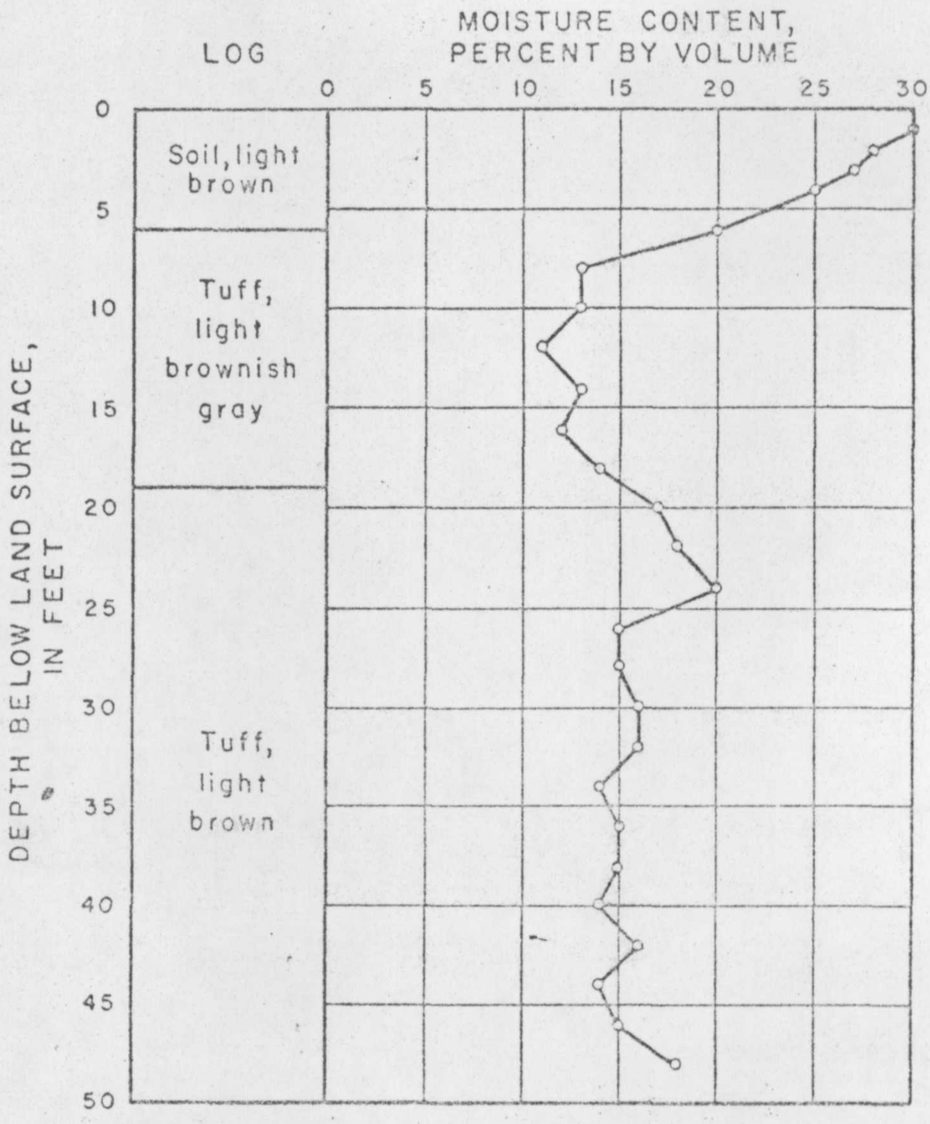
Figure 6.--Log and moisture content of soil and tuff in test hole DPS-4



Location: Project grid, N93 + 80, E122 + 85
Date drilled: 2-7-66
Altitude: 7,214 feet above mean sea level
Depth: 50 feet
Diameter: 4-inches

Figure 7.--Log and moisture content of soil

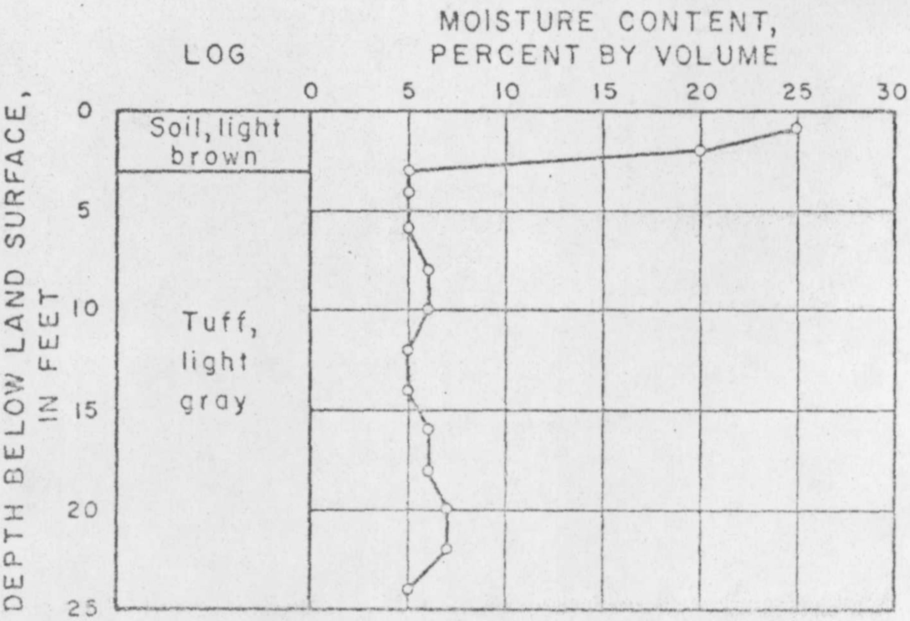
and tuff in test hole DPS-5



Location: Project grid, N92 + 58, E122 + 10
Date drilled: 2-8-66
Altitude: 7,216 feet above mean sea level
Depth: 50 feet
Diameter: 4-inches

Figure 8.--Log and moisture content of soil

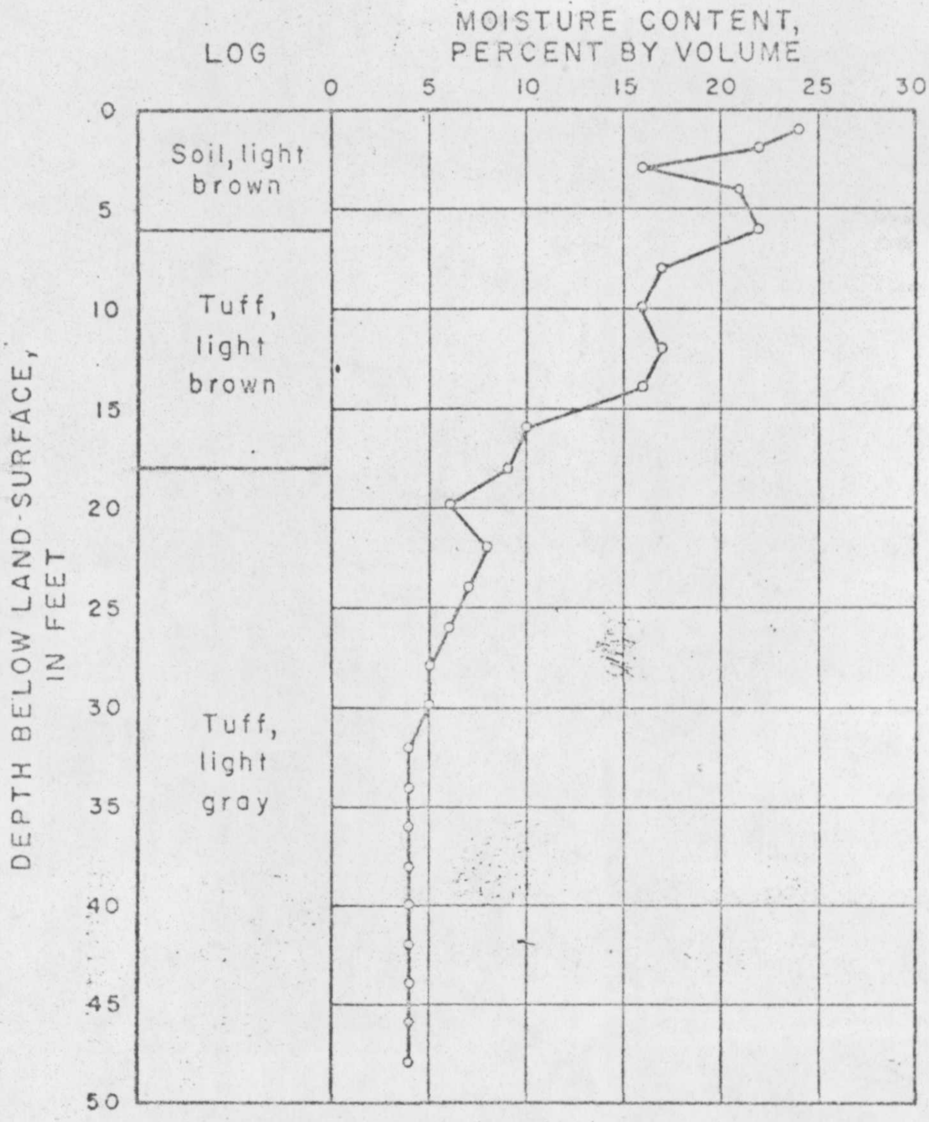
and tuff in test hole DPS-6



Location: Project grid, N94 + 41, E135 + 69
Date drilled: 2-8-66
Altitude: 7,185 feet above mean sea level
Depth: 25 feet
Diameter: 4-inches

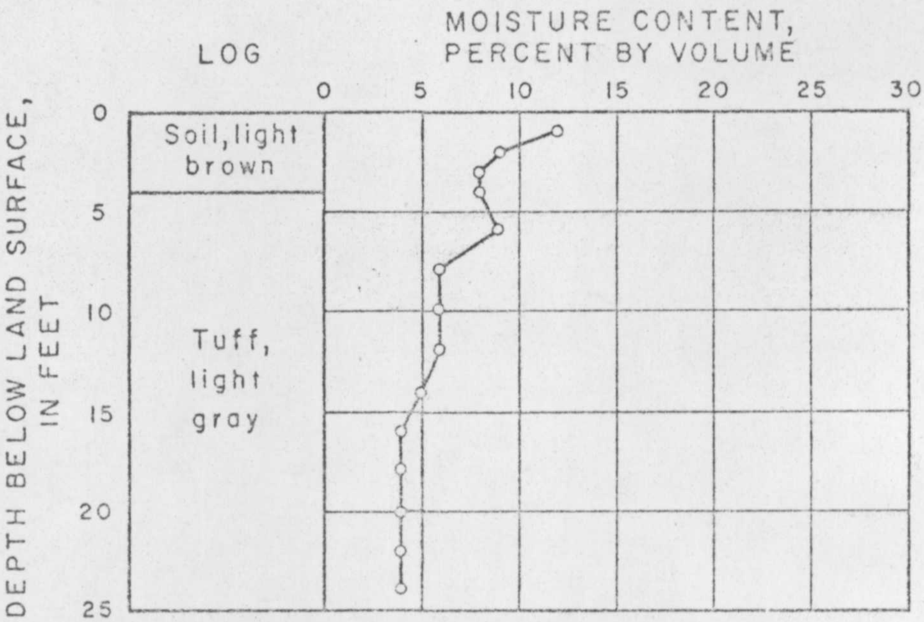
Figure 9.--Log and moisture content of soil

and tuff in test hole DPS-7



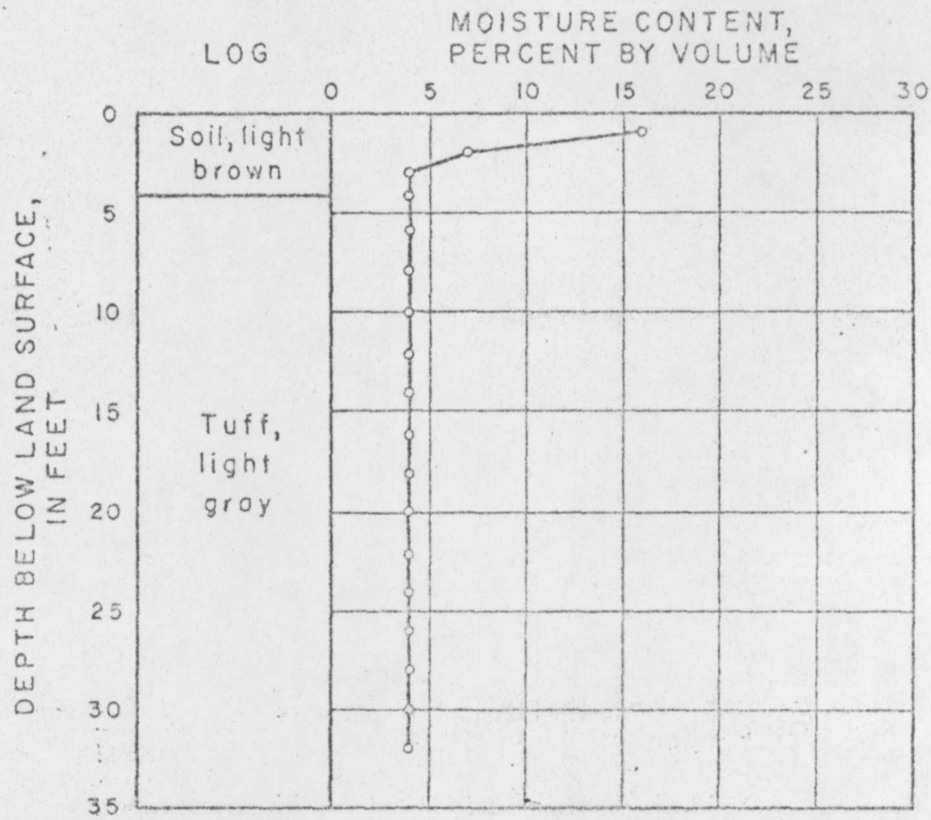
Location: Project grid, N93 + 66, E138 + 06
Date drilled: 2-8-66
Altitude: 7,181 feet above mean sea level
Depth: 50 feet
Diameter: 4-inches

Figure 10--Log and moisture content of soil and tuff in test hole DPS-8



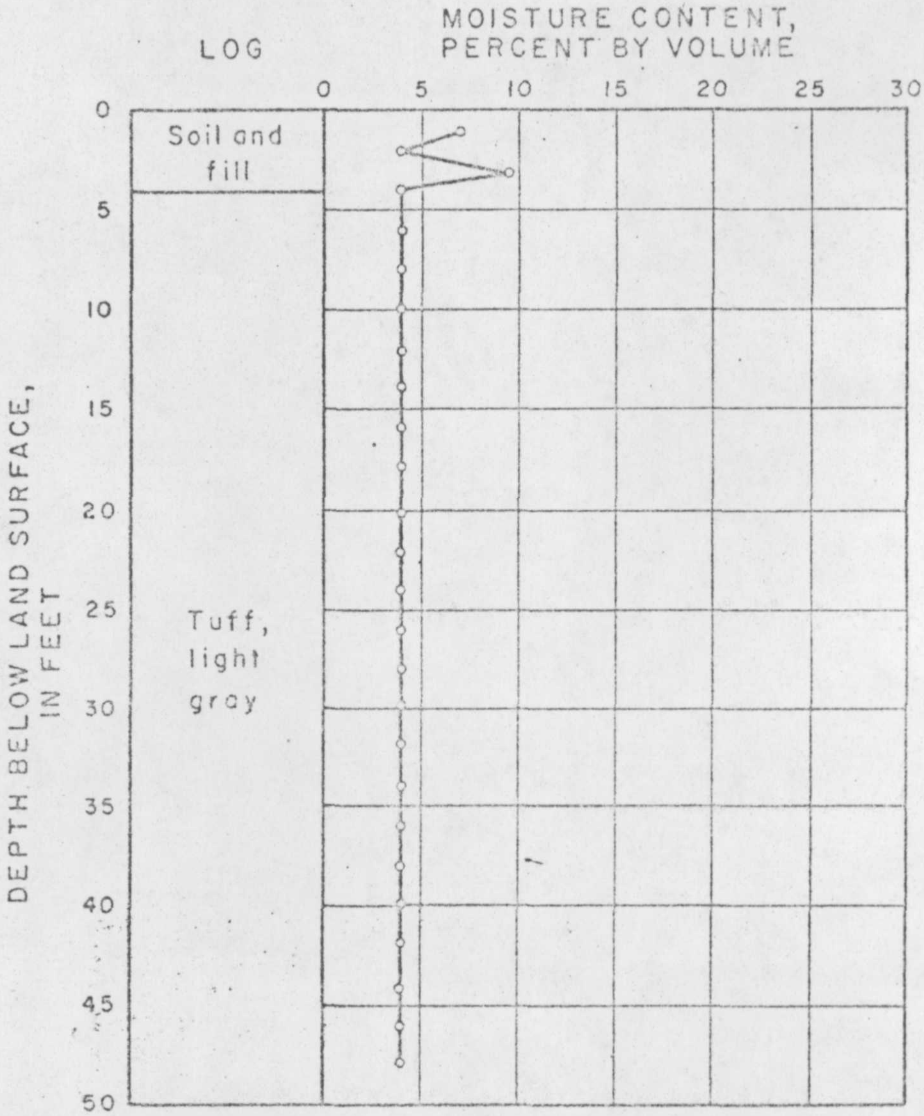
Location: Project grid, N93 + 57, E135 + 19
Date drilled: 2-9-66
Altitude: 7,180 feet above mean sea level
Depth: 25 feet
Diameter: 4-inches

Figure 11.--Log and moisture content of soil and tuff in test hole DPS-9



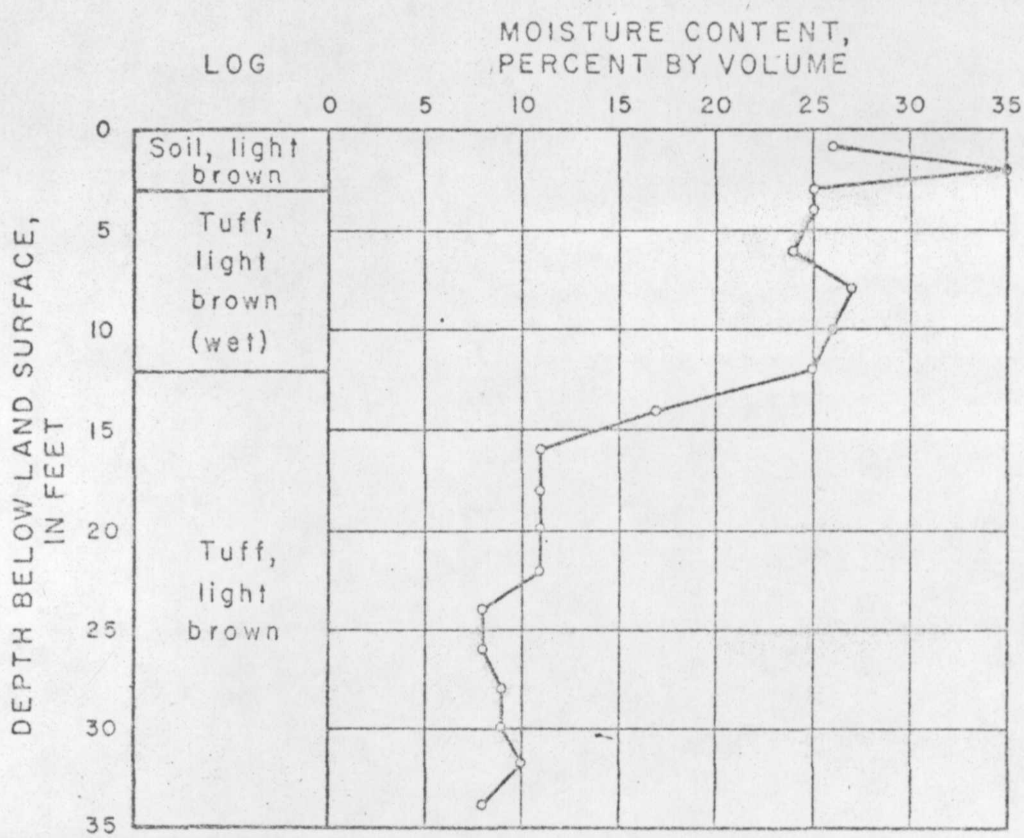
Location: Project grid, N93 + 66, E131 + 55
Date drilled: 2-9-66
Altitude: 7,182 feet above mean sea level
Depth: 35 feet
Diameter: 4-inches

Figure 12.--Log and moisture content of soil and tuff in test hole DPS-10



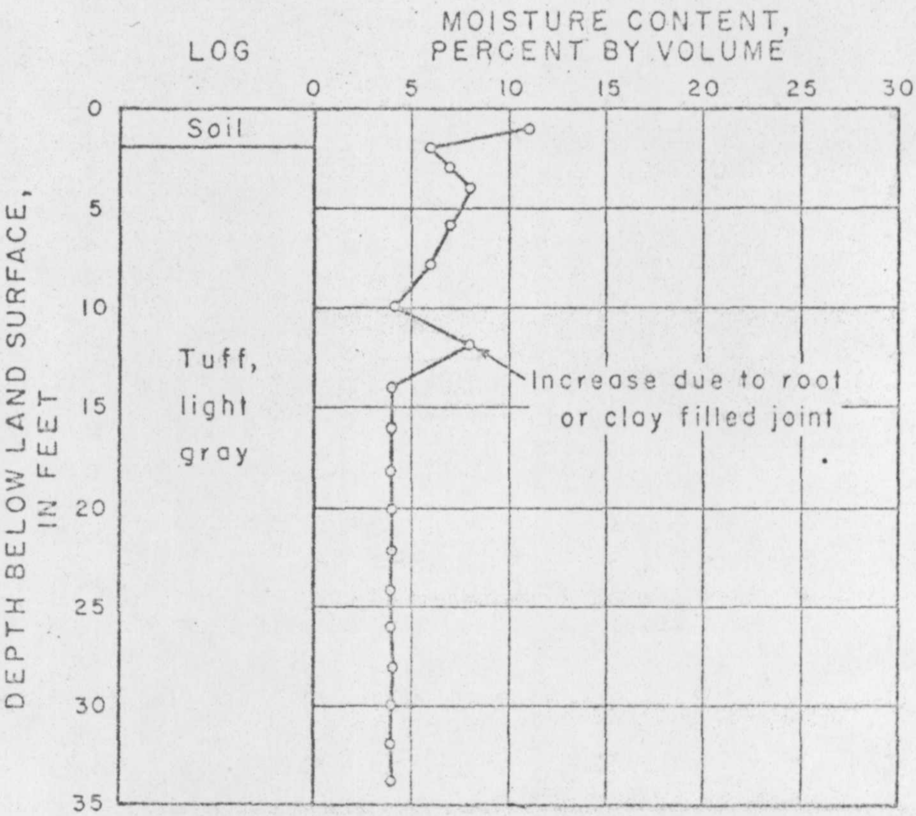
Location: Project grid, N93 + 21, E128 + 51
Date drilled: 2-9-66
Altitude: 7,192 feet above mean sea level
Depth: 50 feet
Diameter: 4-inches

Figure 13.--Log and moisture content of soil and tuff in test hole DPS-11



Location: Project grid, N92 + 79, E125 + 21
Date drilled: 2-9-66
Altitude: 7,192 feet above mean sea level
Depth: 36 feet
Diameter: 4-inches

Figure 14.--Log and moisture content of soil and tuff in test hole DPS-12



Location: Project grid, N91 + 39, E122 + 72
Date drilled: 2-9-66
Altitude: 7,210 feet above mean sea level
Depth: 35 feet
Diameter: 4-inches

Figure 15.--Log and moisture content of soil

and tuff in test hole DPS-13

Table 1.--Radiochemical analyses of soil and tuff from test hole DPS-1.

Depth (feet)	Material	Gross alpha (d/m/g)1/	Gross beta-gamma (d/m/g)1/	Plutonium (d/m/g)1/	Uranium (μg/g)2/
0- 1	Soil	0.4	3.1	<0.4	<0.5
1- 2	Soil	.5	3.0	< .4	< .5
2- 3	Soil	.7	3.6	< .4	< .5
3- 5	Tuff	.3	2.4	< .4	< .5
5-10	Tuff	.3	6.0	< .4	< .5
10-15	Tuff	.6	2.7	< .4	< .5
15-20	Tuff	.7	3.6	< .4	< .5
20-25	Tuff	.4	2.2	< .4	< .5
25-30	Tuff	.3	1.0	< .4	< .5
30-35	Tuff	.2	1.2	< .4	< .5
35-40	Tuff	.3	.6	< .4	< .5
40-45	Tuff	.4	1.2	< .4	< .5
45-50	Tuff	.4	.0	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 2.--Radiochemical analyses of soil and tuff from test hole DPS-2.

Depth (feet)	Material	Gross alpha (d/m/g)1/	Gross beta-gamma (d/m/g)1/	Plutonium (d/m/g)1/	Uranium (μg/g)2/
0- 1	Soil	0.9	9.1	<0.4	<0.5
1- 2	Soil	.5	2.8	< .4	< .5
2- 3	Soil	.8	.6	< .4	< .5
3- 5	Tuff	.6	.3	< .4	< .5
5-10	Tuff	.3	1.8	< .4	< .5
10-15	Tuff	.6	2.5	< .4	< .5
15-20	Tuff	.6	3.3	< .4	< .5
20-25	Tuff	.5	2.1	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 3.--Radiochemical analyses of soil and tuff from test hole DPS-3.

Depth (feet)	Material	Gross alpha (d/m/g)[1]	Gross beta-gamma (d/m/g)[1]	Plutonium (d/m/g)[1]	Uranium (µg/g)[2]
0- 1	Soil	1.2	12.6	<0.4	<0.5
1- 2	Soil	.3	4.3	< .4	< .5
2- 3	Soil	.1	1.6	< .4	< .5
3- 5	Tuff	.1	1.5	< .4	< .5
5-10	Tuff	.6	1.3	< .4	< .5
10-15	Tuff	.3	.0	< .4	< .5
15-20	Tuff	.1	.0	< .4	< .5
20-25	Tuff	.1	.1	< .4	< .5
25-30	Tuff	.1	.1	< .4	< .5
30-35	Tuff	.5	1.6	< .4	< .5
35-40	Tuff	.4	.7	< .4	< .5
40-45	Tuff	.0	.1	< .4	< .5
45-50	Tuff	.1	.7	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 4.--Radiochemical analyses of soil and tuff from test hole DPS-4.

Depth (feet)	Material	Gross alpha (d/m/g)1/	Gross beta-gamma (d/m/g)1/	Plutonium (d/m/g)1/	Uranium (μg/g)2/
0- 1	Soil	0.3	4.3	<0.4	<0.5
1- 2	Soil	1.1	4.9	< .4	< .5
2- 3	Soil	.0	.0	< .4	< .5
3- 5	Tuff	.2	.0	< .4	< .5
5-10	Tuff	.3	1.9	< .4	< .5
10-15	Tuff	.1	1.3	< .4	< .5
15-20	Tuff	.5	.6	< .4	< .5
20-25	Tuff	.9	4.6	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 5.--Radiochemical analyses of soil and tuff from test hole DPS-5.

Depth (feet)	Material	Gross alpha (d/m/g)[1/]	Gross beta-gamma (d/m/g)[1/]	Plutonium (d/m/g)[1/]	Uranium (μg/g)[2/]
0- 1	Soil	0.5	4.5	<0.4	<0.5
1- 2	Soil	.9	4.8	< .4	< .5
2- 3	Soil	.3	2.7	< .4	< .5
3- 5	Tuff	.1	3.4	< .4	< .5
5-10	Tuff	.1	1.5	< .4	< .5
10-15	Tuff	.4	3.6	< .4	< .5
15-20	Tuff	.3	1.3	< .4	< .5
20-25	Tuff	.3	1.6	< .4	< .5
25-30	Tuff	1.0	7.6	< .4	< .5
30-35	Tuff	.5	3.1	< .4	< .5
35-40	Tuff	.2	.9	< .4	< .5
40-45	Tuff	.2	2.5	< .4	< .5
45-50	Tuff	.3	4.6	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 6.--Radiochemical analyses of soil and tuff from test hole DPS-6.

Depth (feet)	Material	Gross alpha (d/m/g)1/	Gross beta-gamma (d/m/g)1/	Plutonium (d/m/g)1/	Uranium (µg/g)2/
0- 2	Soil	0.8	6.1	<0.4	<0.5
2- 5	Soil	.7	4.6	< .4	< .5
5-10	Soil and tuff	.8	4.0	< .4	< .5
10-15	Tuff	.6	3.3	< .4	< .5
15-20	Tuff	.8	5.2	< .4	< .5
20-25	Tuff	1.2	5.7	< .4	< .5
25-30	Tuff	.8	3.4	< .4	< .5
30-35	Tuff	.5	2.7	< .4	< .5
35-40	Tuff	.3	3.6	< .4	< .5
40-45	Tuff	.2	2.8	< .4	< .5
45-50	Tuff	.2	3.9	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 7.--Radiochemical analyses of soil and tuff from test hole DPS-7.

Depth (feet)	Material	Gross alpha (d/m/g)1/	Gross beta-gamma (d/m/g)1/	Plutonium (d/m/g)1/	Uranium (μg/g)2/
0- 2	Soil	1.2	5.5	<0.4	<0.5
2- 5	Soil and tuff	.6	3.9	< .4	< .5
5-10	Tuff	.2	1.3	< .4	< .5
10-15	Tuff	.3	1.5	< .4	< .5
15-20	Tuff	.5	2.4	< .4	< .5
20-25	Tuff	.4	2.7	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 8.--Radiochemical analyses of soil and tuff from test hole DPS-8.

Depth (feet)	Material	Gross alpha (d/m/g)1/	Gross beta-gamma (d/m/g)1/	Plutonium (d/m/g)1/	Uranium (μg/g)2/
0- 2	Soil	0.6	3.3	<0.4	<0.5
2- 5	Soil	.5	4.9	< .4	< .5
5-10	Soil and Tuff	.4	5.8	< .4	< .5
10-15	Tuff	.3	3.6	< .4	< .5
15-20	Tuff	.4	2.2	< .4	< .5
20-25	Tuff	.4	1.3	< .4	< .5
25-30	Tuff	.1	1.0	< .4	< .5
30-35	Tuff	.6	3.4	< .4	< .5
35-40	Tuff	.2	4.9	< .4	< .5
40-45	Tuff	.4	4.6	< .4	< .5
45-50	Tuff	.4	3.0	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 9.--Radiochemical analyses of soil and tuff from test hole DPS-9.

Depth (feet)	Material	Gross alpha (d/m/g) 1/	Gross beta-gamma (d/m/g) 1/	Plutonium (d/m/g) 1/	Uranium (μg/g) 2/
0- 2	Soil	0.7	2.4	<0.4	<0.5
2- 5	Soil and Tuff	.5	2.1	< .4	< .5
5-10	Tuff	.4	3.7	< .4	< .5
10-15	Tuff	.5	1.8	< .4	< .5
15-20	Tuff	.5	3.7	< .4	< .5
20-25	Tuff	.3	1.0	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 10.--Radiochemical analyses of soil and tuff from test hole DPS-10

Depth (feet)	Material	Gross alpha (d/m/g) 1/	Gross beta-gamma (d/m/g) 1/	Plutonium (d/m/g) 1/	Uranium (μg/g) 2/
0- 2	Soil	0.4	3.1	<0.4	<0.5
2- 5	Soil and Tuff	.3	3.0	< .4	< .5
5-10	Tuff	.8	2.5	< .4	< .5
10-15	Tuff	.6	2.7	< .4	< .5
15-20	Tuff	.6	4.3	< .4	< .5
20-25	Tuff	.5	2.7	< .4	< .5
25-30	Tuff	.2	2.1	< .4	< .5
30-35	Tuff	1.0	.7	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 11.--Radiochemical analyses of soil and tuff from test hole DPS-11

Depth (feet)	Material	Gross alpha (d/m/g) 1/	Gross beta-gamma (d/m/g) 1/	Plutonium (d/m/g) 1/	Uranium (µg/g) 2/
0- 2	Soil	0.3	2.1	<0.4	<0.5
2- 5	Soil and Tuff	.6	4.0	< .4	< .5
5-10	Tuff	.4	1.3	< .4	< .5
10-15	Tuff	.5	1.9	< .4	< .5
15-20	Tuff	.5	2.8	< .4	< .5
20-25	Tuff	.5	1.2	< .4	< .5
25-30	Tuff	.7	3.0	< .4	< .5
30-35	Tuff	-	-	-	-
35-40	Tuff	.6	1.9	< .4	< .5
40-45	Tuff	.9	2.7	< .4	< .5
45-50	Tuff	.5	1.8	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 12.--Radiochemical analyses of soil and tuff from test hole DPS-12

Depth (feet)	Material	Gross alpha (d/m/g)1/	Gross beta-gamma (d/m/g)1/	Plutonium (d/m/g)1/	Uranium (µg/g)2/
0- 2	Soil	0.8	1.2	<0.4	<0.5
2- 5	Soil and Tuff	.4	1.6	< .4	< .5
5-10	Tuff	.4	.4	< .4	< .5
10-15	Tuff	.3	1.0	< .4	< .5
15-20	Tuff	.4	.0	< .4	< .5
20-25	Tuff	.5	3.0	< .4	< .5
25-30	Tuff	.8	.9	< .4	< .5
30-35	Tuff	.4	.6	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Table 13.--Radiochemical analyses of soil and tuff from test hole DPS-13

Depth (feet)	Material	Gross alpha (d/m/g) 1/	Gross beta-gamma (d/m/g) 1/	Plutonium (d/m/g) 1/	Uranium (μg/g) 2/
0- 2	Soil	1.0	4.3	<0.4	<0.5
2- 5	Tuff	.7	.0	< .4	< .5
5-10	Tuff	.4	2.1	< .4	< .5
10-15	Tuff	.7	2.8	< .4	< .5
15-20	Tuff	.6	.0	< .4	< .5
20-25	Tuff	.8	.9	< .4	< .5
25-30	Tuff	.9	1.9	< .4	< .5
30-35	Tuff	.4	.4	< .4	< .5

1/ Disintegrations per minute per gram.

2/ Micrograms per gram.

Description of soil and tuff

The light-brown clay soil cover of the mesa is derived from the weathering of the underlying tuff. The granules and sand-size particles of the soil consist mainly of quartz and sanidine crystals and fragments, and a few fragments of latite or rhyolite. The clay minerals making up most of the silt and clay fractions are montmorillonite and illite (Staritsky, 1949). The soil is generally thickest along the axis of the mesa and thinnest toward the edges of the canyon where the tuff is exposed. Near the pit the soil thickness ranges from 2 to 6 feet.

The rhyolite tuff underlying the soil is the Tshirege Member of the Bandelier Tuff of Pleistocene age (Griggs, 1964). The deepest test holes (depth 50 feet) penetrated only the uppermost ashflow.

The light brownish-gray and the light-brown tuff (both partly weathered) are composed of quartz and sanidine crystals and crystal fragments in a light brownish-gray or light-brown ash matrix that is in the process of breaking down into clay by weathering. A few rock fragments of latite or rhyolite are present. Pumice fragments are weathered to light-brown or light brownish-orange clays. The light-gray and the grayish white tuff (both unweathered) consist of quartz and sanidine crystals and crystal fragments and a few rock fragments of pumice and latite or rhyolite in a gray ash matrix. The gray ash matrix contains pores that are capillary in size.

Numerous joints slightly open to closed, occur in most of the ashflow tuffs. The majority of the joints are near vertical although a few are nearly horizontal. Joints terminating in the soil zone are filled with brown clay.

Water moving through the soil zone to the tuff moves more readily into the tuff than into the clay filled joints as the tuff is more permeable than the clay. If water should move into an open joint, the extreme dryness of the tuff and capillary pores cause the water to be rapidly absorbed into the tuff that forms the joint face. Joints impede the movement of water because the water in the tuff is held in tension within the small pore spaces and the joints form breaks in the capillary pores through which movement occurs.

The total thickness of the Bandelier Tuff underlying the mesa at the disposal pit exceeds 800 feet. The tuff is in the zone of aeration; the zone of saturation is at a depth of about 1,200 feet below the surface of the mesa.

The fill material, covering the solid wastes in the pit, is composed of a mixture of soil and tuff. The tuff is being altered by weathering to silt and clay. The thickness of the fill material above the wastes is unknown.

Distribution of moisture in soil and tuff

Annual precipitation on the Pajarito Plateau is about 18 inches. Although water not removed by surface drainage infiltrates into the soil, the downward movement of water is impeded by the dense transition zone between the soil and tuff. Little if any water from precipitation moves into the underlying tuff, except in areas where the natural soil cover has been disturbed (Abrahams and others, 1961). Thus in the waste-pit area it is possible that moisture may have moved downward through the fill, thence downward and laterally into the tuff due to capillary action. Movement of water through the tuff is slow.

The moisture content in the soil and tuff adjacent to the walls of the test holes drilled around the waste-pit was determined with a neutron-scattering moisture probe and with a portable electronic scaler. The scaler readings were converted to moisture content (percent by volume) from a calibration chart. The holes were sealed after logging to avoid changing the conditions. The logging interval was 1 foot in the soil zone and 2 feet in the tuff. The moisture content of the soil and tuff, from normal infiltration of precipitation, decreases with depth. Significant increases of moisture content with depth in the tuff probably indicate lateral movement.

In the soil zone the moisture content ranged from less than 4 percent by volume (DPS-10, fig. 12 and DPS-13, fig. 15) near the contact of the soil and tuff to 35 percent (DPS-12, fig. 14) above the contact. The moisture content of the light brownish-gray and light-brown tuff (weathered) ranged from 8 percent to 27 percent by volume (DPS-12, fig. 14). The moisture content of the light-gray tuff was generally less than 10 percent in test holes pentrating this unit.

The distribution of moisture in the soil and tuff in eight of the test holes indicates moisture content generally decreases with depth. The moisture content of the soil and tuff in five test holes decreased from land surface to depths between 12 and 24 feet [test holes DPS-1 (fig. 3), DPS-4 (fig. 6), DPS-5 (fig. 7), DPS-6 (fig. 8), and DPS-7 (fig. 9)] then increases slightly. The moisture increase at these depths ranges from 2 percent by volume (DPS-7) to 7 percent (DPS-5 and DPS-6). The moisture content of the tuff is in the low moisture range, less than 20 percent by volume. The effective porosity of the tuff (void space available to transmit water) is estimated from laboratory determination of similar tuff to range between 35 to 40 percent by volume, thus moisture is being moved by capillary action, and the tuff is not saturated.

Distribution of radioactivity in soil and tuff

One hundred twenty-three samples of soil and tuff were collected from the thirteen test holes and analyzed for radioactive contamination (tables 1 through 13) to determine if water had moved contaminants into the adjacent soil and tuff. Six samples of soil and tuff were collected from an area known to be free of contamination (except by fallout) and were analyzed to establish the natural radiation of the soil and tuff.

The interval sampled varied from hole to hole for the first five feet, depending on the thickness of the soil zone; however, each hole was sampled in the tuff at five-foot intervals to total depth. The samples (soil and tuff) were analyzed for gross alpha and gross beta radioactivity and specific analyses for plutonium and uranium.

The radioactivities measured on the soil and tuff samples from the test holes varied in gross alpha radioactivity from 0.0 d/m/g (disintegrations per minute per gram) to 1.2 d/m/g and in gross beta radioactivity from 0.0 d/m/g to 12.6 d/m/g. The analyses of the samples collected near the waste pit indicate that they contain no more radioactivity than those collected from an area far removed from the area of waste disposal (table 14). In general, all the surface samples (soil) analyzed had a slightly higher gross beta radioactivity than those samples taken at depth. This is probably due to radionuclide absorption of fall-out material.

Table 14.--The range of gross alpha and gross beta radioactivities of soil and tuff.

Material	Samples from test holes near the radioactive waste in the pit		Samples from test holes in an area where there is no radioactive waste contamination	
	Gross alpha 1/	Gross beta 1/	Gross alpha 1/	Gross beta 1/
	Range	Range	Range	Range
Soil	0.0 to 1.2	0.0 to 12.6	1.2 to 1.4	4 to 12.0
Tuff	0.0 to 1.2	0.0 to 7.6	.4 to 1.6	4.5 to 10.8

1/ Distintegrations per minute per gram.

The specific analyses of the samples of soil and tuff, for plutonium and uranium, showed no indication of contamination from the wastes in the pit. Plutonium was less than 0.4 d/m/g and uranium was less than 0.5 μg/g (micrograms per gram). Analyses of soil and tuff from an area free from contamination contained less than 0.4 d/m/g of plutonium and less than 0.5 μg/g of uranium.

Conclusions

The moisture content of the tuff adjacent to the test holes and the pit was low, generally less than 10 percent by volume, thus the tuff is not saturated. Radiochemical analyses of the soil and tuff from the test holes showed no indication of radioactive contamination. The amount of water moving into the waste materials is not sufficient to cause migration of radioactive contaminates, or else the volume of and rate of movement has not been great enough to move the contaminates laterally into the tuff. No information is available on the radioactivity beneath the pit.

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